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A study was conducted to determine if filter location has a differential effect on tracking performance in the BLASER simulator. Eight male volunteers viewed a scale model tank target through BLASER's unity optical sight while attempting to keep the crosshairs fixed on the moving target. Five laser protective filters were used in each of two positions -- at the objective or the ocular -- for a total of 10 filter-position combinations. Volunteers had 5 trials under each condition. Variability in tracking performance was assessed using the horizontal SD error following each trial. The results of the ANOVA indicated that while

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the choice of laser protective materials significantly affected performance, neither filter position nor the filter-type/position interaction affected tracking performance. Simi .r findings may hold true for other military systems employing optics with unity magnification.

LABORATORY NOTE NO. 85–51

POSITION EFFECTS OF LASER PROTECTIVE MATERIALS ON SIMULATOR TRACKING PERFORMANCE

PAUL R. BEST, PhD, MAJ MSC
RICHARD R. LEVINE, PhD, CPT MSC
DAVID A. STAMPER, MA
and
JEROME W. MOLCHANY, BS, SP5

DIVISION OF OCULAR HAZARDS

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LETTERMAN ARMY INSTITUTE OF RESEARCH
PRESIDIO OF SAN FRANCISCO, CALIFORNIA 94129

Position effects of laser protective materials on simulator tracking performance--Best et al

Human Subjects participated in these studies after giving their free and informed voluntary consent. Investigators adhered to AR 70-25 and USAMRDC Reg 50-25 on the use of volunteers in research.

Edwin S. Beatrice 30 Oct 84
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(Signature and date)

POSITION EFFECTS OF LASER PROTECTIVE MATERIALS ON SIMULATOR TRACKING PERFORMANCE---Best et al

Laser protective filters are under investigation for use in daysight optics to protect soldiers' eyes and vision from directed energy sources on the battlefield. These filters have various optical characteristics and are known to affect differentially the visual performance of operators who must perform while viewing through them (1). Recent work (2) suggests that the external placement of laser filters onto systems employing direct view optics, at the ocular or the objective, may play a critical role in the mission effectiveness of these systems. It is presently unknown whether a similar phenomenon exists for BLASER, our laboratory's viscous-dampeu optical tracking simulator. The present study was therefore designed to determine if filter location (in front of or behind the optics) has a differential effect on tracking performance in the BLASER simulator.

METHODS

Volunteers. Eight males, ranging in age from 23 to 40 yr, served as voluntary participants. All the volunteers were from our laboratory and had extensive training in using the BLASER tracking simulator.

Procedure. Pursuit tracking performance data were collected under simulated field conditions in the BLASER tracking simulator. The simulator consisted of a scale model Warsaw Pact T-62 tank target on a terrain board and a full-sized sandbag bunker which housed the viscous-damped optical tracking device. The target was track-mounted and driven in a single direction (left-to-right) at a constant angular velocity of 5 mrad/sec. The track was laid out over a level course at a constant arc from the center post of the tracking device at a simulated distance of 1000 meters. Trials commenced with the target stationary and the observer's sight crosshairs aligned with a 0.5 mrad aiming patch located centrally on the tank between the turret and the hull. On the command, "Ready -- GO," the target traversed the terrain for approximately 15 sec while the observer tracked the target patch. A television camera, mounted coaxially with the unity optics of the tracking device, imaged an infrared light-emitting diode located in the center of the aiming patch on the target. This signal, invisible to the operator, provided a reference point for a microprocessor and associated software to measure electronically the accuracy of tracking performance.

Previous work (3) in the BLASER simulator has demonstrated that laser protective materials typically produce no adverse effects on tracking ability under bright light, but may affect performance under conditions of reduced illumination. Therefore, we restricted our analysis to a low-light condition only (early dawn/late dusk) in order to determine what additional effects, if any, the location of the filters might have when placed at opposite ends of the BLASER optical system. The low-light simulation was achieved by turning off the bunker lights and inserting neutral density materials within the optics of the tracking device. The average terrain luminance at the exit aperture of the tracking optics was calculated to be 0.8 lm/m^2. To improve visibility of the darkened terrain, the volunteers were permitted to dark adapt for 10 min. During this time and throughout testing the only light permitted to enter the bunker was through the optics of the tracking device.

Filter materials. Five filters were tested, each one in two positions, for a total of 10 filter-position combinations. The filters were placed either at the objective (i.e., between the optics and the target) or at the ocular (i.e., between the volunteer's eye and the optics). The order of presentation of these 10 filter-position combinations was assigned randomly in an exhaustive manner so that each volunteer tracked under all 10 combinations.

The five materials chosen represented a range of technological approaches and potential solutions to the problem of multiwavelength laser protection. All were used in previous tracking tests and, based upon the results of those tests, the materials were selected deliberately to produce an expected range of tracking difficulty under low-light conditions. The materials [and their designated nomenclatures] were: (a) a clear crown glass substrate with greater than 98% visible transmission used as a control material [BK-7-0]; (b) a three-wavelength thin-film interference coated filter designed to reject specific red, green, and near-IR laser lines [BK-7-3]; (c) a reflecting holograph sandwiched between two layers of clear glass and with rejection characteristics similar to (b) [Holograph]; (d) Schott BG-18 glass -- the U.S. Army's current basis of issue for protection against currently fielded laser systems [BG-18]; and (e) a neutral density material with a nominal optical density of 1 (and a luminous transmission of 10%) throughout the visible spectrum [ND-1]. Luminous transmissions for filters (b), (c), and (d) were 46%, 66%, and 44%, respectively.

The entire test entailed three days. Day-1 was a practice session consisting of 20 trials without the insertion of filters in the simulator. Days-2 and -3 were filter days, each consisting of one warm-up trial (without filters) followed by 25 filter trials. The 25 trials consisted of 5 tracking trials under 5 of 10 filter-position combinations, randomly presented. Ten minutes were allowed for partial dark adaptation prior to tracking. A 1-min rest period was provided between each of the 5 trials within a filter-position combination. Approximately 3-min were required to change filters after every five filter trials. After each trial the volunteers were given performance feedback consisting of the percent time-on-target and the horizontal standard deviation score. In previous studies with these same volunteers, these procedures have yielded stable performance and a high level of tracking accuracy.

Statistical Design and Analysis. The experiment was designed to be analyzed by a two-factor analysis of variance with repeated measures on both factors. The two factors were the five filter materials and the two filter positions. The dependent measure was the standard deviation (SD) of the horizontal tracking error. The SD scores were transformed logarithmically to normalize their distribution. The data were analyzed using the Biomedical Computer Programs BMD-2V for multifactorial, mixed designs (4). The Newman-Keuls test was used for post hoc comparisons (5). The .05 level of significance was used for all analyses.

RESULTS AND DISCUSSION

The five laser protective filters had a significant effect on tracking performance as measured by the horizontal SD scores ($df=4,28$; $F=78.38$,; $p<0.05$). However, neither filter position nor the interaction between filter type and filter position significantly affected tracking. These results are illustrated in Figure 1. As can be seen, ND-1 clearly had a much greater effect on tracking, in terms of performance degradation, than the other materials. In addition, good correlation was observed between the filters' luminous transmittances and performance. Averaging the SD scores of each filter type across position, significant differences were found between ND-1 and the other filters. Small, but statistically significant differences were found also between BK-7-0 (the clear glass control) and all the other materials less the holograph. As expected, error levels with the holographic, the 3-wavelength coated, and the BG-18 filters fell between those observed with clear glass and ND-1. No significant differences were found among these three materials.

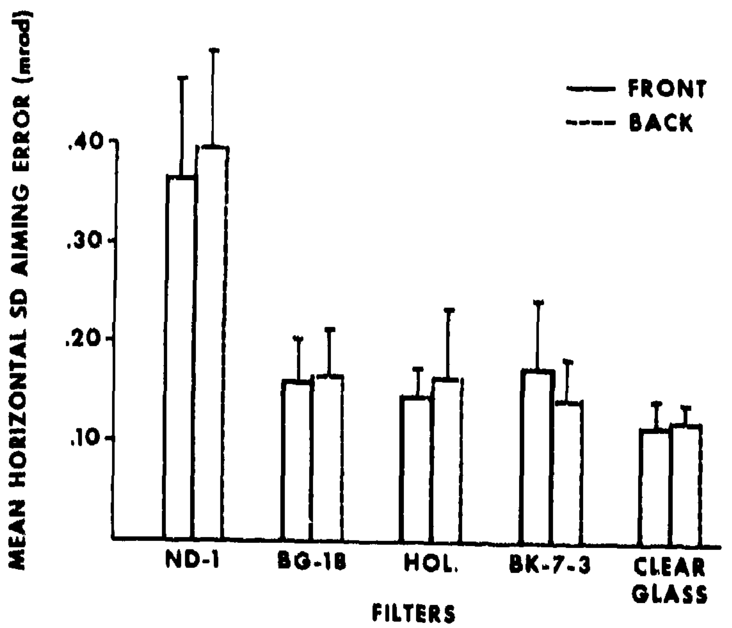

Figure 1. Tracking error as a function of filter and filter position.

CONCLUSIONS AND RECOMMENDATIONS

The results of this study indicate that, while a particular filter material (e.g., ND-1) may adversely impact performance under conditions of reduced ambient illumination, tracking is not affected differentially by the external placement of the material in the optical system of BLASER. These findings not only provide us with critical information required for the conduct of future BLASER studies designed to evaluate laser protective materials, but they also suggest that filter placement may not be a critical factor in other sights containing unity power optics. These results stand in sharp contrast to our previous work with sights containing optical magnification (2), where filter position, and optical quality and characterization significantly affected operator performance.

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* References to sensitive documents have been omitted. Identification of such references may be obtained upon written request to the Commander, Letterman Army Institute of Research, Presidio of San Francisco, CA 94129 (ATTN: SGRD-UL-Z).